CONFINING HYDROGEN:
A Low Energy Route to Room Temperature Superconductivity

STEM for BRITAIN

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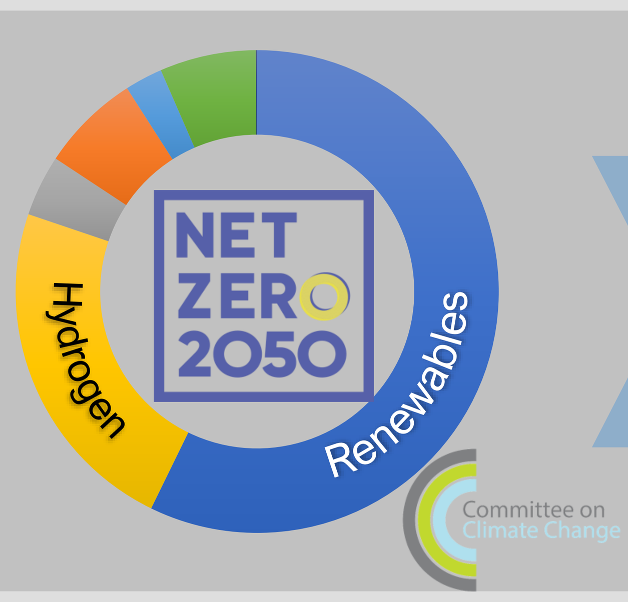
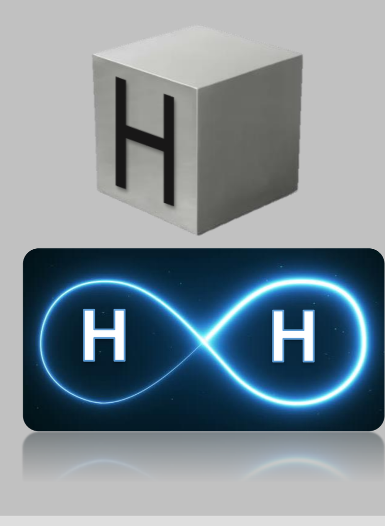
Context

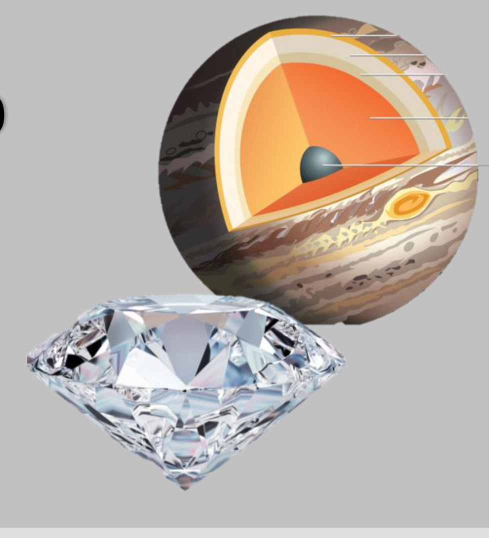


Problems

Solution



Technical Challenge



Net Zero
- By 2050 UK emissions must reach net zero.
- **Renewable energy** sources need to reach around 57 % of our energy production.
- Transition to **hydrogen** as a non-polluting alternative to fossil fuels.

eStorage
- Intermittent renewable energy necessitates **long-term energy storage.**
- Chemical storage in hydrogen requires bulky pressurised gas tanks.
- Need compact and safe **energy storage.**

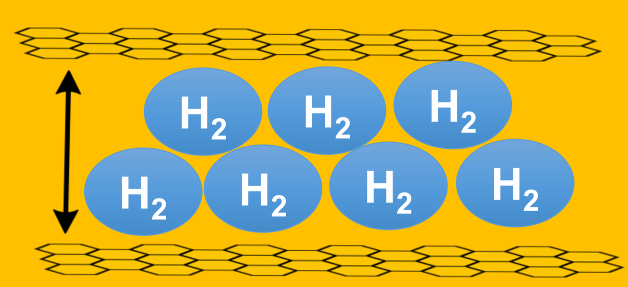
Metallic Hydrogen
- Densest form of solid hydrogen - a **supremely compact** way to store clean fuel.
- Conducts electricity with zero resistance at room temperature (**a superconductor**!).
- Renewable electricity could be stored in superconductive rings with **no power loss.**

Pressure
- Metallic hydrogen is formed at **very high pressures** – close to the centre of a planet!
- Energy intense and currently impractical to produce…
- Need **an alternative way** to reach solid densities at lower pressures and higher temperatures.

Solution

DENSE HYDROGEN *Via* NANOCONFINEMENT

Density of hydrogen could be increased by confining in porous carbon sponges

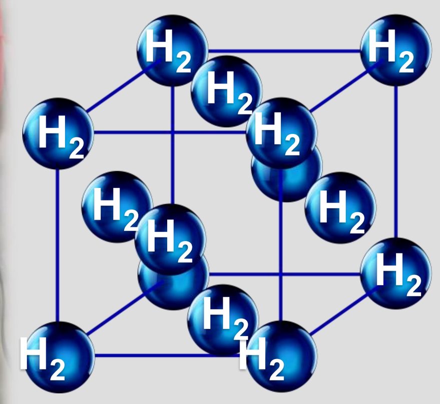


Previous experimentation indicates that confining hydrogen in very small carbon pores produces solid-like densities at **pressures ~2000 times lower** than classically observed!

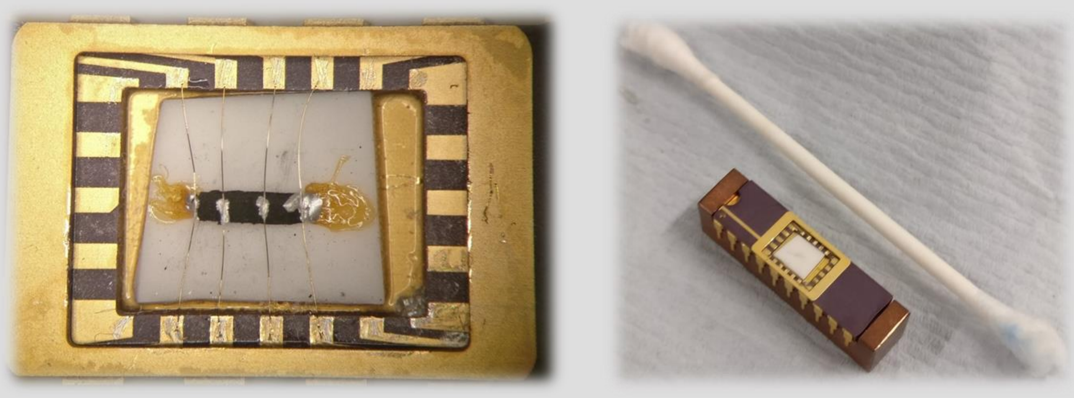
"Route to Room Temperature Superconductivity"

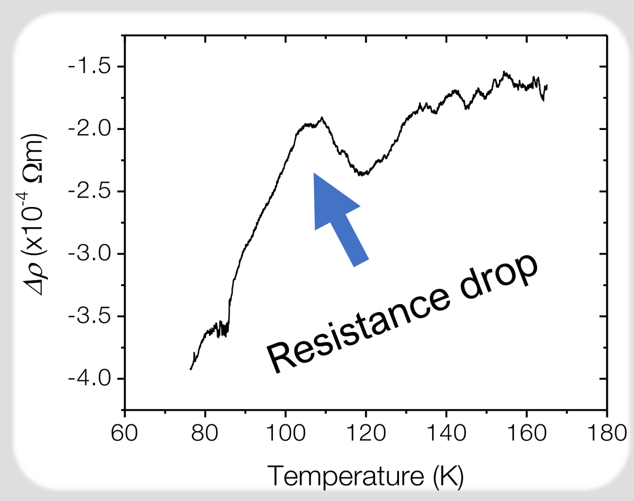
Using nanoconfinement as a '**pre-densification' step** and the application of additional pressure, may allow us to **create metallic hydrogen** at significantly lower pressures than the centre of a planet.

1) Proof of Principle – It is Solid!
- **Neutron Diffraction** reveals structural information of a material as well as definitive proof of its state.
- Our recent studies show for the first time, the crystal structures of nanoconfined hydrogen - fully **confirming that dense-solid hydrogen** does form in carbon sponges. Furthermore, we observe them at temperatures never seen previously.

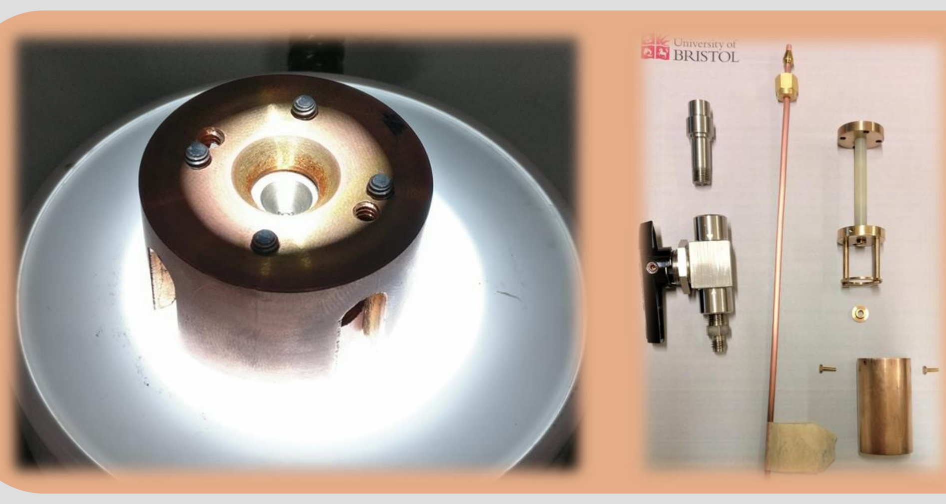


2) Zero Resistance
- **Electrical resistivity** measurements can identify a switch to superconductivity but also can identify changes in state.
- Low pressure results observed a **drop in resistivity** upon densification, signifying a switch in the hydrogen's state.





What does this mean?
- Solid hydrogen = more hydrogen = **compact fuel storage**.
- Lower pressures and higher temperatures = **safer storage**.
- Results so far are promising for the next stage of the project: increasing the pressure to find **a low energy route to room temperature superconductivity…**



Next Steps: Building Pressure
Construction of high pressure experimental apparatus

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